General Application Name: Fire and Rescue

Product / Service / Function Name: Hazmat and Disaster Pre-Planning

P/S/F Description:

Hazmat and disaster pre-planning activities should take place well before a potential disaster. This type of planning is different from strategic planning and analysis, which takes place during the recovery from an disaster. It is also different from emergency operations management, which involves creating and guiding the contingencies and procedures that need to occur during an emergency situation. This process typically involves locating key locations of emergency management assets, as well as locations that might be considered as points of origin for a major hazardous situation or emergency (e.g., dams, chemical plants, stadiums, etc.) and creating various emergency scenarios.

Information technology gives emergency management planners new tools with which to work. Key among these new technologies is Geographic Information Systems (GIS). GIS offers key decision makers, command staff and administrative personnel tremendous advantages to collecting, analyzing, describing and communicating information. GIS is often employed by emergency management planners and command staff for hazmat and disaster pre-planning to guide them in developing alterative plans for the five key steps in emergency management: planning, mitigation, preparedness, response, and recovery.

Pre-planning for emergencies requires an agency to develop action plans to be used to prepare for an emergency, guide emergency management personnel during an emergency, and record information about that emergency upon completion of a recovery effort. It is to the advantage of the emergency management agency to create preconceived, but flexible plans to respond to situations as they unfold. Maps can assist this process by portraying the spatial information required to inform key decision makers. This document discusses how GIS can aid emergency management planners to create these procedures and guidelines.

Product / Service / Function

1. Spatial Data

   Minimum Requirements

General Description	Data Layer
Emergency Data	Incident Locations
	Police Stations
	Fire Stations
	Fire Response Zones
	Hospitals
	Hazardous Material Sites
	Major Public Infrastructure
Natural Features	Parks
	Open Water
Transportation	Street Centerlines
Socio-Political Data	Municipal Boundary

Optional Enhancements

General Description	Data Layer
Emergency Data	911 Call Locations
	Mass Care Centers
	Evacuation Site
	Evacuation Routes
	Traffic Control Points
	Superfund Sites
	Food and Medical Stockpiles
	Emergency Management Assets
	Type of Hazmat Material
Land Base / Planimetric Data	Building Footprints
	Tax Parcels
	Zoning Districts
	Land Use
Natural Features	100-Year Floodplain
	Topography
Transportation	Street Double lines (Right of Way)
	Public Transit Routes
	Railroads
Utility Data	Water Mains
	Hydrants
	Gas Mains
	Electrical Lines
	Telecommunication Conduit
	Sewer Mains
Socio-Political Data	Zip Code Boundaries
	Census Tracts
	Census Block Groups
	Neighborhoods & Subdivisions
Industrial	Dams
	Mines
	Quarries
Other Data	Digital Orthophotography

2. Attribute Data:

Minimum Requirements

General Description	Field Name
Emergency Data	Unique Incident Identification Number
	Occurrence Date
	Occurrence Time
	Address
	Type Code

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	Day Code
	Hour
	Patrol/Fire Unit Zone
	Patrol Zone Workload
	Patrol Zone Fire Demand
	Patrol Zone Response Time
	Type of Hazardous Material
	Type of Emergency
Person Data (aggregate)	Key Contact Name
	Key Contact Role/Position
	Key Contact Residence Address
	Key Contact Work Address
	Key Contact Home Phone Number
	Key Contact Work Phone Number
	Key Contact Cell/Pager Phone Number
Census/Employment Data (aggregate)	Miscellaneous Demographic and Household
	Major Employment Centers
	Major Employment Center Daytime Population
	Major Employment Center Evening Population
	Major Employment Center Nighttime Population

Optional Enhancements

General Description	Field Name
Calls for Service (CFS) (aggregate)	CFS

3. Data Acquisition Options

There are many sources for the spatial data that an emergency operations management system requires. Digital incident data can be obtained from the local law enforcement agency's CAD and/or RMS (records management system). A CAD/RMS can be as simple as a file cabinet full of the paper police response reports collected by officer at the scene of an incident. A CAD/RMS is, however, most typically a digital database (ex. MS Access, SQL Server, Oracle, mainframe flat-file) that is used to enter these paper reports into a computer for storage. The CAD/RMS can then serve as more than a reservoir of incident reports, it can be utilized to generate summary reports, used for advanced statistical analysis, or used as the 'base' from which 'data' is extracted for mapping. The incident data can either be extracted from the CAD/RMS on a regularly scheduled basis and placed into a data warehouse, or the emergency operations management system can link directly to this database. The mapping system is then used to geocode, or spatially locate, each event using a street centerline file or a parcels data layer. A street centerline data layer represents each street in a community by a single line that has attached to it its address range. Tax parcels represent a property by a polygon that has information attached to it pertaining to ownership, address, and other assessment data.

In either case, the address of an incident record is matched to a parcel or location along the street centerline and a point feature is created to represent that event. Tax parcels are typically maintained at the county level. Street centerline data layers of varying qualities can be obtained by a number of vendors. The market is relatively competitive, and prices will vary with quality of the data. Relevant vendors that provide this kind of spatial data on a regional and national scale include: NAVTECH (www.navtech.com), GDT (www.geographic.com), TeleAtlas (www.teleatlas.com), and ESRI (www.esri.com). Geocoding can also be used to create other data layers that use single addresses, such as fire stations, schools, hospitals, bars, prisons, convenience store/retails centers, etc.

Other spatial data layers can be obtained through the Internet from various government sources. Municipal boundaries, zip code, census tract, and block group boundaries can be obtained in digital format through the U.S. Census Bureau (www.census.gov). Floodplains can be obtained through the FEMA Web site (www.fema.com).

Land Base and Planimetric data are typically generated at the county level. County staff may create this data themselves or contract the project out to a consulting firm. This data often includes tax parcels, zoning districts, land use, parks, open water, street double lines (Right of Way), railroads, and 911 dispatch records.

Regardless of the source of the data, each data layer used for emergency planning should be consistent with, or be modified to match, the Virginia Base Mapping Project orthophotography, or electronic versions of aerial photos. This is vital for data consistency across the state and facilitates data sharing across jurisdictional boundaries. The digital orthophotography provides an excellent base data layer on which to symbolize incident data and plan tactical operations.

4. Data Conflation Options

Data conflation is a process by which two digital data layers, usually of the same area at different points in time, or two different data layers of the same area, are geographically "corrected" through geometrical and rotational transformations so that the different layers can be overlaid on one another. Also called "rubber-sheeting," this process allows a technician to adjust the coordinates of all features on a data layer to provide a more accurate match between known locations and a few data points within the base data set. A good base layer to use for data conflation is the VBMP orthophotos since many features can be seen or interpreted. The need and processes for conflation varies between sets of data, users, and feature types. Any dataset that is updated independently by different departments can be consolidated through conflation. Within most local governments, individual departments are responsible for maintaining specific datasets within their expertise; therefore, conflation is not often necessary. Often, reprojecting the data into a different coordinate system will take care of the misalignment of different data sets. Most industry-standard GIS software has the ability to perform data conflation. Commonly conflated data layers include: parcels, street centerlines, census boundaries, fire and emergency response zones/boundaries, and any layer that was built using either the parcels or street centerlines.

Each data layer used for an emergency planning application should use the Virginia Base Mapping Project orthophotography for the conflation process. This is vital for data consistency across the state, and facilitates data sharing across jurisdictional boundaries. It is critical that the street centerlines are accurately placed so that the address information is correct.

5. GUI / Programming Options:

There are many options for developers of desktop emergency pre-planning systems. The following are three approaches:

- Standard GIS desktop application that can be customized to the user's needs
- Existing commercial emergency planning system
- Hiring a consultant to develop a custom system from scratch.

Using a standard GIS application often requires a significant amount of training and customization. Whereas the initial cost may be low, the time invested in learning these solutions may generally increase the overall expense of implementation. Standard GIS software packages deliver more robust data integration, analysis, and cartographic capabilities than do other emergency situation analysis applications. They have a greater user support infrastructure that allows users to overcome problems quickly. Options for using an existing, industry-standard GIS software application that can be customized for emergency pre-planning include those listed in the following table:

Standard GIS Software Vendors:

Vendor	**Software**	**Web Address**
ESRI	ArcView 3.x	http://www.esri.com
ESRI	ArcGIS 8.x	http://www.esri.com
MapInfo	Professional 7.0	http://www.mapinfo.com
Intergraph	GeoMedia 5.0	http://www.intergraph.com/gis
Autodesk	Map 5.0	http://www.autodesk.com

There are an increasing number of vendors developing and implementing emergency situation software. These products may often cost more than standard GIS solutions because of the customization that is required to fit the application into the agency's business practices and/or connect to its CFS database or CAD/RMS. The advantage is that a tailored emergency operations management application provides just the functionality that is needed, decreasing the overall application overhead common to industry-standard GIS software. Options for using an existing, commercial emergency operations management system include those listed in the following table:

Commercial Software

Vendor	**Software**	**Web Address**
Omega Group	FireView	www.crimeanalyst.com
Applied Ordnance Technology	MaxResponder	www.maxresponder.com
SAIC	CATS	www.saic.com/products/simulation/cats/cats.html

The final option for developing and implementing an emergency pre-planning application is to contract with a consultant. This option makes certain that a product will fulfill an agency's requirements. Unlike the first option, which requires the emergency management agency to modify its own process/technology to fit the system, the system fits existing business practices. A consultant will be able to develop an application that works with the wide range of CFS

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databases and CAD/RMS that currently exist within the state. Also, training and follow-up user support is often provided at a much more substantial level than with other options.

An emergency pre-planning application would ideally allow the user to plot locations of emergency management assets, as well as locations that might be considered as points of origin for a major hazardous situation or emergency (dams, chemical plants, stadiums, etc.). The application would also include functions for creating various "what if" emergency scenarios to help decision-maker determine whether or not their emergency plans are feasible. A GIS is an ideal tool to use for showing the flow of people and resources from one area of a jurisdiction to another. GIS is also capable of creating evacuation routes and hazmat transportation routes based on the distribution of an area's population as well as its transportation infrastructure.

6. Internet Functionality and Options:

The Internet has proven itself as a viable solution for emergency management agencies to centralize the maintenance and management of services and data. As more emergency management agencies are implementing Web-based solutions, they are finding that the Internet does require them to change the nature of an application or its usefulness. Using the Internet, software can be easily updated, and users gain greater accessibility to the applications and information they need for their specific tasks through simple, user-friendly interfaces.

The Internet can play a role in disseminating emergency management information. Simple maps can be made available via the Web that delineate evacuation routes, approved hazmat routes through the jurisdiction, 100 year floodplain limits, mass care centers, and other emergency asset locations. This could give the public an easily accessible form of information from which to learn proper responses to disaster situations. The following table lists Internet GIS software that can be customized to provide the functions mentioned above:

GIS Internet Solutions

Vendor	Internet Software	Web Address
ESRI	ArcIMS	http://www.esri.com/software/arcims
MapInfo	MapXtreme, MapX	http://www.mapinfo.com
Intergraph	GeoMedia WebMap	http://www.intergraph.com/gis/gmwm
Autodesk	MapGuide	http://www.autodesk.com

7. Technical Requirements:

Minimum Technical Requirements
At its most basic level, an emergency planning system can be located on a single, stand-alone workstation, or even a laptop. This workstation/laptop would have a hard drive that stores all of the spatial data layers, as well as a database containing a copy of all of the incident records for the emergency management agency. A typical workstation/laptop running off-the-shelf software should have the following minimum specifications:

Processor: Pentium 3, 450 MHz
RAM: 128MB SDRAM at 133MHz
Hard Disk: 20GB (min.)
Monitor 1: 19"

Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional
Printer:	8x11 office-grade color printer

Optimum Technical Requirements:
A more complex emergency planning system may require multiple components, including servers, desktop workstations, ruggedized laptops, and/or handheld devices. For a client-server application such as this, the system should rely on a fairly robust server computer and high-end workstations. Some examples specifications of the necessary equipment are listed below:

Server

Processor:	Min. 2x Processors, 1.7 GHz, 512K cache
RAM:	Min. 2x 512MB RIMMS
Hard Disk:	Min. 2x 80GB +RAID
Monitor 1:	19"
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD drive
Modem:	56K
Network Card:	10/100 mbps

Workstation

Processor:	Pentium 4, 1.5 GHz
RAM:	512MB SDRAM at 133MHz
Hard Disk:	20GB (min.)
Monitor 1:	19”
Monitor 2:	17”
Floppy Drive:	3.5”
CD-ROM:	12x/8x/32x CD-RW drive
Modem:	56K
Network Card:	10/100 mbps
OS:	Windows 2000/NT/XP
Office:	Windows 2000 Professional

Other Components

Printer:	8x11 office-grade color printer and 8x11 production b/w printer
Plotter:	HP DesignJet 1055CM
Tape Backup:	Tape Library Server
UPS:	APC 1400 (or other similar)
Scanner:	11x17
Handheld:	Compaq IPAQ
Network:	T1

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8. Administrative/Management Requirements

At the beginning of the project the assigned project manager of the local emergency management agency should consider completing some, if not all of the following tasks that relate to the administrative requirements of an emergency pre-planning project:

- Determine, with or without the assistance of a consultant hired to develop the system, the preliminary vision and goals of the project.
- Determine the stakeholders (e.g. fire departments, local/state/federal emergency management groups, local hospital administration/planning staff) of an emergency situation project within their own jurisdiction and with larger government entities that they interact with.
- Coordinate an initial stakeholders meeting where the vision and goals of the project are expressed and the background of GIS technology is described, if needed.
- Coordinate with other municipal agencies for data sharing provisions.
- Determine a mechanism of communication to keep the stakeholders aware of the progress of the project.
- Develop a basic understanding of the available precedents in their region/state and research the available technologies that can be applied to their project.

Upon project completion, a simple desktop emergency planning system will require very little administrative support. Administrative tasks may include loading or upgrading new versions of the software or patches, providing for constant data flow from the 911 dispatch database or RMS, and maintaining yearly support contracts on the hardware and software.

At the point where the system grows beyond single desktop users, a devoted administrator or system manager needs to be established. This is essential for the following reasons:

- The system will now be interfacing with other technology systems already in place. Therefore, someone needs to maintain contact with the technology personnel that maintain these systems.
- The manager needs to put into place quarterly training schedules to maintain user knowledge of the system.
- Funding will undoubtedly be required to either maintain the system long-term, or continue to expand the system, which requires funding research and applications for grants.
- Emergency operations management only succeeds when it is updated periodically, implemented for every emergency situation and supplemented with rigorous analysis and planning.

9. Costs:

Hardware	**Typical Unit Cost**
Minimum Workstation	$2,000
Optimum Workstation	$3,200
Laptop	$2,400
Database Server	$12,000
Printer (8x11 color)	$700
Printer (8x11 b/w production)	$2,000
Plotter	$12,000
UPS	$700

Scanner	$1,500
Handheld	$300-$700

Software (all prices included license)	**Typical Unit Cost**
Standard GIS desktop software	$700-$10,000
Desktop vendor emergency operations management application	$2,000-$6,000
Customized desktop vendor solution	$5,000-$15,000

Miscellaneous	**Typical Unit Cost**
Training – focused vendor emergency situation mapping training (per person)	$700-$1,000
Training – general GIS	$700-$1,200
Licensing-desktop	$100-$500
Maintenance (per year)	$8,000-$15,000

10. Standards / Guidelines Summary

- Always maintain a unique identification number with every incident, spatial feature, and event recorded within the system.
- Standardize street naming conventions to make certain of proper geocoding.
- If there are multiple streets with the same name (e.g., Main St.) then standardize additional fields, such as borough name or zip code, that are collected to differentiate the streets.
- Create standard Common Place-name file.

McDonald's	236 Johnson St
Grant Statue	14th St. & Willits St
Central Park	1500 Warrington Rd
The Pit	6550 Templeton Ln
K&A	Kensington Ave & Allegheny Ave

- Collect zip codes for all incidents. This facilitates cross-jurisdictional information sharing.
- Standardize use of emergency situation type codes and other data statewide building from national standards such as the National Fire Incident Reporting System (NFIRS).
- Standardize date and time conventions.
- Develop a detailed Quality Assurance/Quality Control (QA/QC) procedure for reviewing the accuracy of the GIS data and its attributes.
- Maintain data in the VBMP standard coordinate system (Virginia State Plane, NAD 83, Survey Feet).
- Create metadata (standard information about GIS data) for each data layer. Metadata tracks the date, origin, coordinate system, and other such information for data layers.

11. Startup Procedures/Steps

There should be a minimum of eight steps involved with an emergency pre-planning application after funding is in place to support the project. The steps can be performed in-house or by a consulting team.

The first task is to complete a detailed Needs Assessment. This process gathers information regarding existing operational procedures, hardware and software, emergency situation data, and personnel needs. It should include interviews of key individuals throughout the emergency management and law enforcement communities and other related government departments to obtain a comprehensive view of the agency's operations, and where GIS might improve them. Basic GIS concepts should be discussed and illustrated to those interviewees that have little prior understanding of GIS or emergency situation analysis and mapping. It is at this time that the project group should discuss the relevance or desire to develop functionality within the system to help in the five key areas mentioned in the introduction: planning, mitigation, preparedness, response, and recovery.

A comprehensive Needs Assessment should then be compiled from the results of the interviews. This document explains the various requirements for an emergency pre-planning system in the following areas: personnel needs, spatial data development needs, tabular/incident data development needs, applicable spatial and temporal emergency situation analysis techniques, basic system requirements, including preliminary, general hardware and software recommendations, and training needs.

The second task is to develop a functional requirements document for the proposed system. This document should describe, as completely as possible, all of the technology and functionality that is to be included in the system. This document is used by the local government agency, or its consultant, as the blueprint for the GIS application or system.

- Hardware specifications
- Software purchases
- Detailed descriptions of work-flow, and examples of the graphic user interfaces
- Describe each tool that is part of that graphic user interface, and its functionality
- Describe how data would flow between the different databases and data warehouses, if applicable
- Describe the redundant security measures that will be put in place to make certain of data integrity and confidentiality, when applicable
- Analytical techniques that the application/system provides the user for emergency pre-planning operations
- Describe each of the potential products (reports, maps, charts, summary tables) that the user will be able to generate within the system

The third task should be to compile or develop an emergency specific spatial data set that can be used by the evolving emergency planning system. Data can be gathered from a number of online sources, as well as county departments. The data layers gathered and maintained should match at least the minimum list provided in Section 1 of this document. At this point, the method of data collection and attributes collected pertaining to an incident should be studied and modified as needed. This might require changes to the agency's CAD/RMS. If changes are warranted, it will be worthwhile in the long run to compile additional information for analysis. This is the point in the project where emergency management assets are geocoded and or digitized onto the data layers that will be used to make maps. Evacuation sites, mass care centers and other emergency managements assess are located and then populated with appropriate attribute information. Other features such as evacuation routes are generated, as well. The product of this step should be the creation of an extensive set of data layers that can be turned on or off for mapping during the pre-planning meetings and strategy sessions.

On completion and acceptance of the functional requirements document and the development of the spatial and attribute data, the system development and test phase can begin. During this time, the application will be customized as it was outlined in the functional requirements phase. The emergency management agency should require periodic reviews of the application at particular milestones, such as 50% and 75% completion. This will make certain that problems with the application will be recognized early in the development process, and that the emergency management agency remains a part of the development process throughout the project timeline.

When the system is nearing 100% completion, it should be installed and tested in the environment in which it will ultimately be used. This allows the users to test the system alongside the application developers, and determine any system integration problems that might arise. It also gives the developers the opportunity to test the application's functionality in a real-world situation. This testing process should be as comprehensive as possible. Each process detailed within the functional requirements should be tested and evaluated at this point.

User training commences once the application reaches 100% completion and is fully documented. Different levels of tutorials and system documentation should be developed depending on the hierarchy of users. Time should be spent at this stage of the project with each potential user of the system to make certain that the proper education occurs. Training should be done through lessons that use real-life examples of system application. This strategy greatly enhances users' ability to apply the functionality to their jobs.

The next phase of the project should include a document that describes a future plan for wider system development. This document accomplishes two goals. The future plan gives the local government agency ideas on how the system might grow to assist other facets of its business practices. Secondly, it provides the agency with a ready-made grant proposal for applying for potential funding sources.

The final phase of a successful emergency pre-planning application is ongoing technical support. The emergency management agency should always include this contingency within its cost estimates of a project for a minimum of three months after a system has been put into place. No matter how effective an application appears, problems and system changes inevitably impact the functionality of a system.

12. Estimated time line and/or implementation (stand alone) schedule:

Phase	**Duration**
RFP/Contract process (construction, posting, proposal acceptance, review, award of contract)	4 months - 1 year
Needs Assessment	1 month
Functional Requirements	1-2 months
Data Development	2-3 months
System Development and Testing	2-4 months
Installation and Testing	1 month
User Training	½ month
Plan for Future Development	¼ month
Ongoing Support	3 months

13. Best Practice Examples in Virginia

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